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Mineral Nutrient Elements of Peach Trees as Affected by Dwarfing Rootstocks

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Summary

The effect of dwarfing rootstocks on leaf mineral nutrient elements of peach(*Prunus persica* Bastch. cv. 'Akatsuki') trees was investigated. *P. japonica* and *P. tomentosa* considerably elevated leaf manganese(Mn) content when used as rootstocks for peaches. When an aqueous $MnCl_2$ solution was applied to soil, the shoot growth was reduced at 500 and 1000 ppm in *P. tomentosa*, and at 1000 ppm in *P. japonica* and red leaf plum(*P. cerasifera*), but not affected even at 1000 ppm in wild peach(*P. persica*). The maximum Mn levels that can be accumulated in any tissue seemed to be about 2000 ppm. The concentration of soil-applied $MnCl_2$ to cause the leaf Mn to saturate was 100 ppm for *P. japonica* and *P. tomentosa* and 500 ppm for red leaf plum. However, the maximum level was not attained in wild peach even when 1000 ppm $MnCl_2$ was treated. *P. japonica* most greatly accumulated Mn in the stems, whereas red leaf plum in the roots. Leaf K and Mg content tended to decrease with increasing soil-applied Mn concentrations.

Introduction

In fruit tree growing, compact-sized trees have been gaining popularity all over the world because it is laborious and time-consuming to manipulate large trees in the orchard practices such as pruning, thinning, chemical spray and picking. One of the methods to make trees compact is to use dwarfing rootstocks. In apples, many dwarfing rootstocks are worldwide available for commercial production. However, useful dwarfing rootstocks are yet unavailable for peaches. We already reported the dwarfing effect of *Prunus tomentosa* and *P. japonica* on 'Ohkubo' peach[4]. Although the trees on these rootstocks produce excellent quality fruit with high soluble solids content[4, 5, 8, 10], some problems including graft-incompatibility[5, 9] and bitter taste of fruit[3, 10] have been documented. By analyzing leaf mineral elements in peach, nectarine and Japanese plum as affected by dwarfing rootstocks, Ogata et al.[7] found that the dwarfing

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rootstocks elevated leaf manganese(Mn) content. In this report, we examined the leaf nutrient status as affected by dwarfing rootstocks and the effect of soil-applied Mn on the growth and nutrient element content in these rootstock species.

Materials and Methods

Plants — We used peach(*Prunus persica* Bastch. cv. 'Akatsuki') trees grafted on rootstocks that were raised from seedlings of wild peach, *P. japonica* and *P. tomentosa*, and cuttings of red-leaf plum(*P. cerasifera*). Their respective one-year-old trees were planted in an orchard of Ehime University in 1981. The number of trees was two on wild peach, six on *P. japonica*, five on red leaf plum and one on *P. tomentosa*. The tree on *P. tomentosa* grew so poorly that we did not employ it until 1985. Since the orchard had been reclaimed from rice paddy field and the soil was considered fertile, no fertilizer had been applied until 1985, when compound fertilizer(N-P-K/16%-10%-14%) was used at a rate of 60 kg/10a in early April and at 20 kg/10a in middle June. The trees were trained to a slender spindle type by annual winter pruning. Pesticides were sprayed as needed.

Leaves were sampled during the growing seasons, wiped with cotton impregnated with 5% acetic acid, and washed with distilled water. The leaves were oven-dried at 90℃ for one hour followed by 60℃ for several days. After grinding, powder was passed through a sieb and used for element analysis.

Mn treatment — By using one-year-old potted(18 cm in diameter) seedlings of wild peach, *P. japonica* and *P. tomentosa* and cuttings of red leaf plum, an aqueous solution of $MnCl_2$(0, 50, 100, 500 and 1000 ppm) was drenched at 200 ml/pot at weekly intervals. Compound fertilizer(N-P-K/16%-10%-14%) was applied at a rate of 2 g/pot at the beginning of the experiment in middle April 1985. The plant growth was monitored by measuring the length of main stem, of which lateral shoots were removed just when they emerged. All plants were harvested and divided into leaves, stems and roots. Leaves were treated similarly as mentioned above. Stems and roots were washed with tap water and oven-dried at 90℃ for one hour followed by 60℃ for several days. These samples were ground, passed through a sieb and served for analysis.

Element analysis — Total nitrogen content was measured by the Kjeldahl method. Phosphorus was determined by spectrophotometry and the other mineral elements with an atomic absorption spectrophotometer.

Results and Discussion

Leaf nutrient as affected by three different rootstocks (1982—1984)

Fig. 1a shows macro element content in leaves of peach trees grafted on three different rootstocks. There was a decreasing tendency in leaf nitrogen(N) content as the leaves aged during the respective growing period. However, there was no close relation between N content and rootstocks. Leaves of trees on *P. japonica* showed lowest potassium(K) and phosphorus(P) content followed by those on wild peach and red leaf plum in 1982 and 1983 but such tendency disappeared after August in 1984.

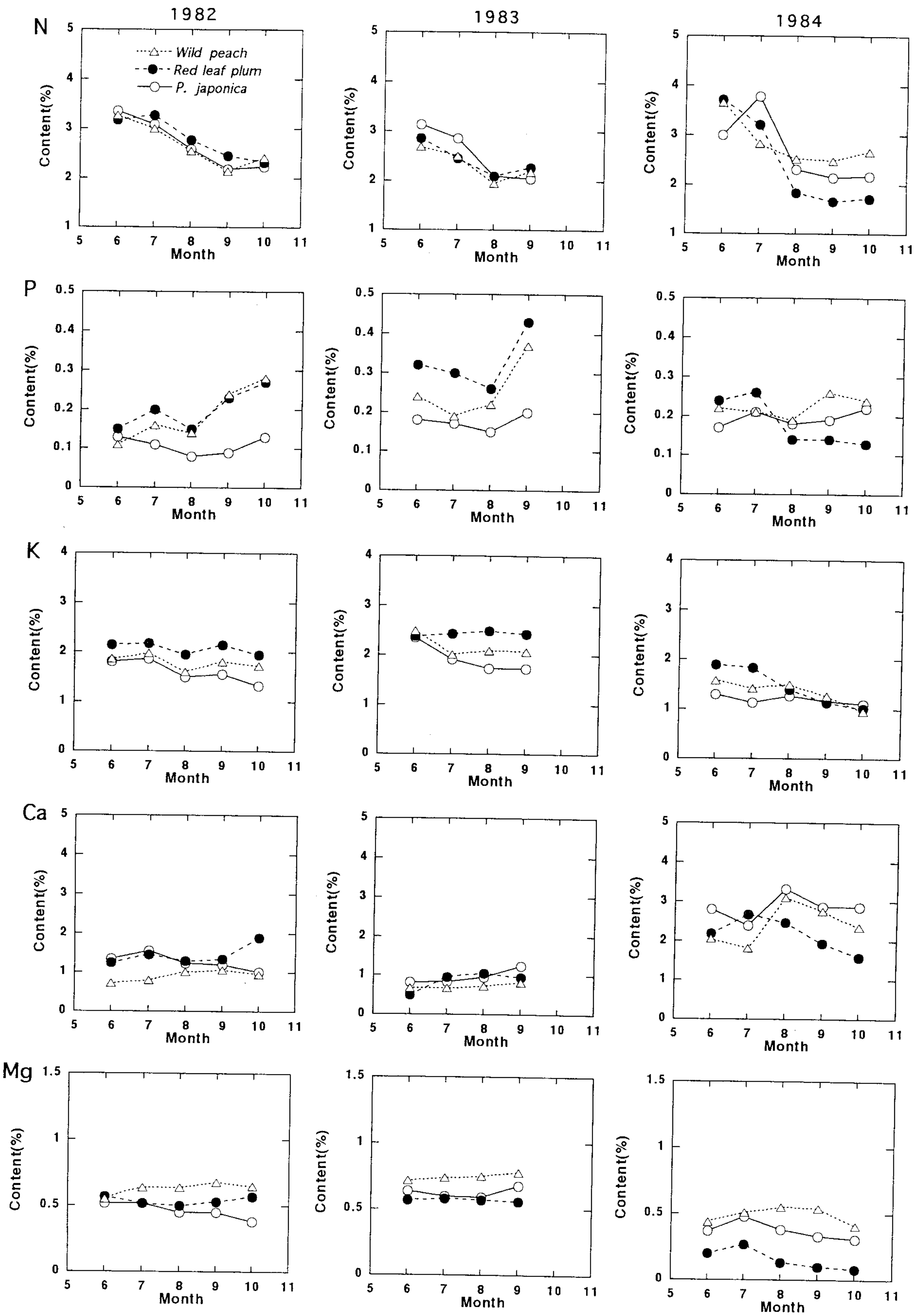

Fig. 1a Effect of three different rootstocks on macro nutrient element content in leaves of 'Akatsuki' peach trees (1982–1984).

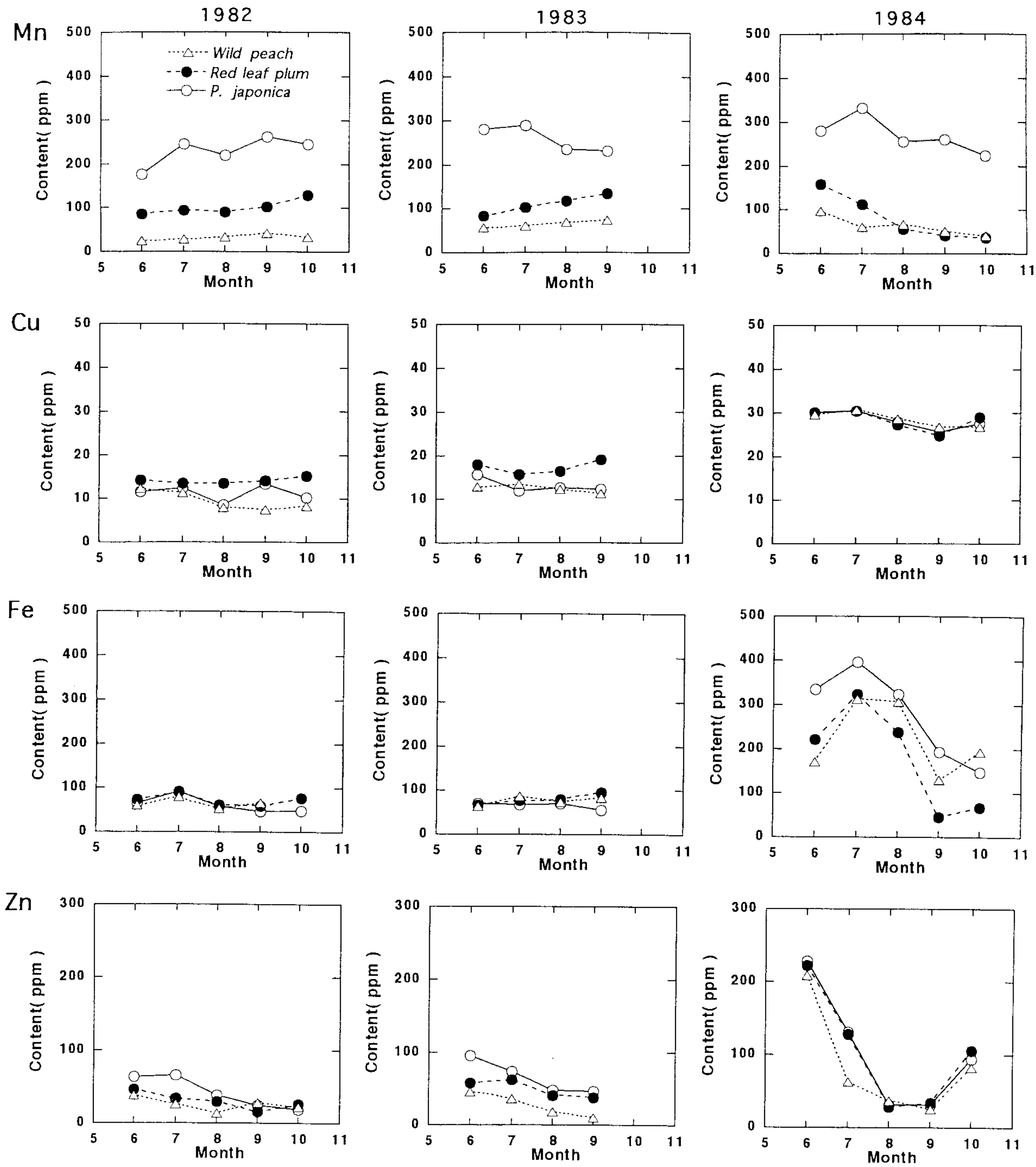

Fig. 1b Effect of three different rootstocks on micro nutrient element content in leaves of 'Akatsuki' peach trees (1982−1984).

Calcium(Ca) content in the leaves in 1984 was greater than in the two previous years. Rootstock effect on leaf Ca content was not so apparent. Contrary to Ca, magnesium(Mg) content in 1984 was lower than in 1982 and 1983. Leaf Mg of trees on wild peach showed consistently higher than on the other rootstocks. Trees on red leaf plum was the second highest in the leaf Mg content in 1982 but became lowest in 1983 and 1984.

Trees on *P. japonica* exhibited consistently the highest leaf Mn content(Fig. 1b). The leaf Mn levels on wild peach showed lowest but it became similar to that of red leaf plum after August in 1984.

Copper(Cu) content in the leaves of trees on red leaf plum showed slightly higher than in those on the other rootstocks in 1982 and 1983, but no difference in 1984. The content in 1984 was a little higher than in the two previous years. Iron(Fe) and zinc(Zn) content were below 100ppm in 1982 and 1983 but they fluctuated greatly in 1984.

Leaf nutrient as affected by four different rootstocks (1985)

We further examined in 1985 nutrient status as affected by four different rootstocks including *P. tomentosa*(Fig. 2). The trees on *P. japonica* showed lowest levels of potassium from June to September.

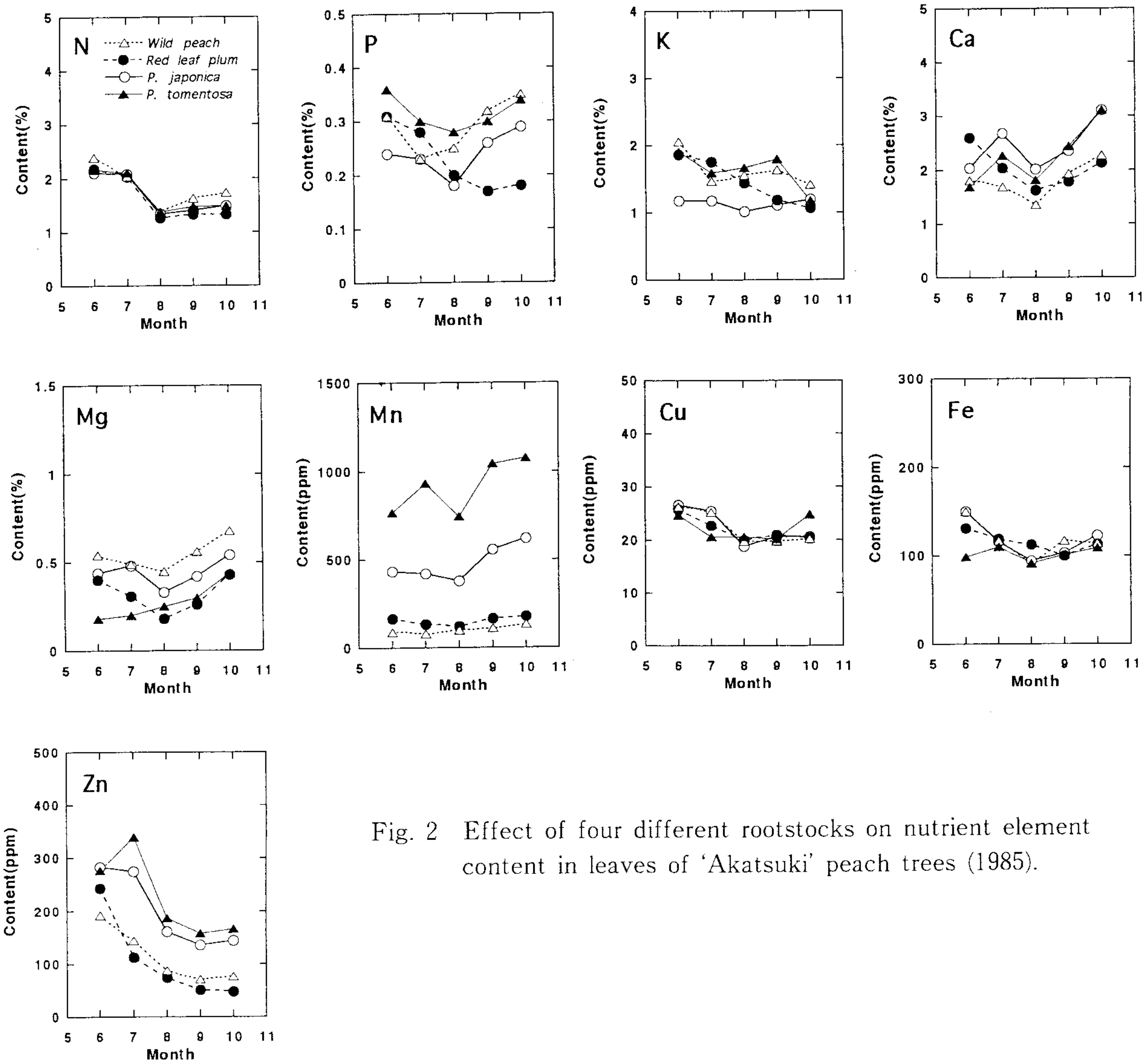

Fig. 2 Effect of four different rootstocks on nutrient element content in leaves of 'Akatsuki' peach trees (1985).

Zn content in the trees on *P. tomentosa* and *P. japonica* was higher than wild peach and red leaf plum rootstocks, both of which are vigorous rootstocks. Leaves of trees on *P. tomentosa* showed the highest Mn content and those on *P. japonica* the next. Wild peach and red leaf plum rootstocks exhibited very low leaf Mn content. Ogata et al.[7] reported that 'Ohkubo' peach grafted on various dwarfing rootstocks such as *P. japonica*, *P. glandulosa*, *P. tomentosa* and *P. triloba* showed higher leaf Mn content than those on peach rootstocks. They also obtained similar observations with nectarine and plum trees on *P. japonica*, *P. tomentosa* and wild peach.

Shoot growth and Mn content in relation to soil-applied Mn

Effect of soil application of $MnCl_2$ solution on the growth of wild peach, red leaf plum, *P. japonica* and *P. tomentosa* was shown in Fig. 3. The growth of wild peach seedlings was not affected by the treatment. On the other hand, the reduced growth was noted at 1000 ppm for red leaf plum and *P. japonica*, and at 500 and 1000 ppm for *P. tomentosa*. Fig. 4 shows Mn content in plant parts of four *Prunus* species as affected by soil Mn application. Leaf Mn

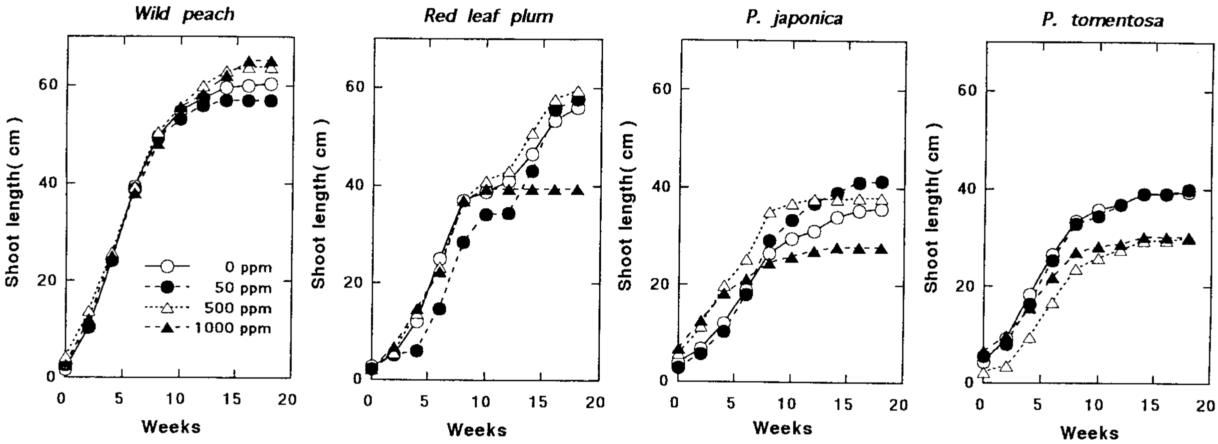

Fig. 3 Effect of soil-applied $MnCl_2$ on shoot growth of four *Prunus* species.

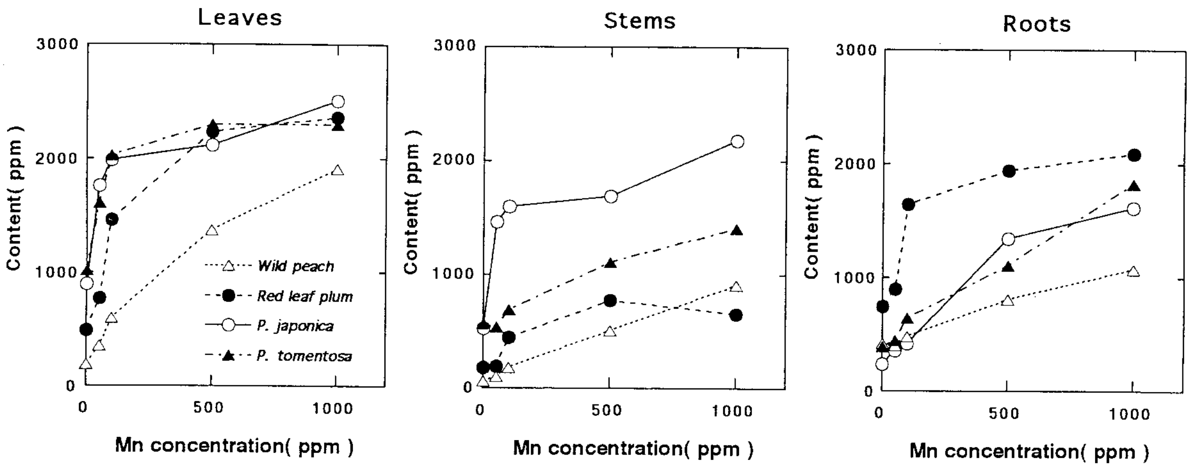

Fig. 4 Effect of soil-applied $MnCl_2$ on Mn content in leaves, stems and roots of four *Prunus* species.

content of *P. japonica* and *P. tomentosa*, which was already high at non-treated control plots like grafted trees as mentioned above, increased to level off at 100 ppm. On the other hand, the content of red leaf plum reached the maximum level at 500 ppm. The saturation levels of leaf Mn seemed approximately 2000 ppm irrespective of species. However, wild peach, which showed the lowest levels, did not reach the saturation levels within the range of treatment.

P. japonica and *P. tomentosa* showed higher stem Mn content than the other two species in the non-treated control plots. Whereas *P. japonica* greatly accumulated Mn in the stems with increasing soil-applied Mn concentrations, *P. tomentosa* did not so great. However, the stem Mn content in wild peach and red leaf plum was lower than in the two dwarfing rootstocks.

In contrast to leaves and stems, red leaf plum had the greatest Mn content in the roots over the range of treatment. The content seemed to reach the maximum level at 100 ppm. There was no difference among the other three species below 100 ppm, but wild peach exhibited the lowest at 500 and 1000 ppm.

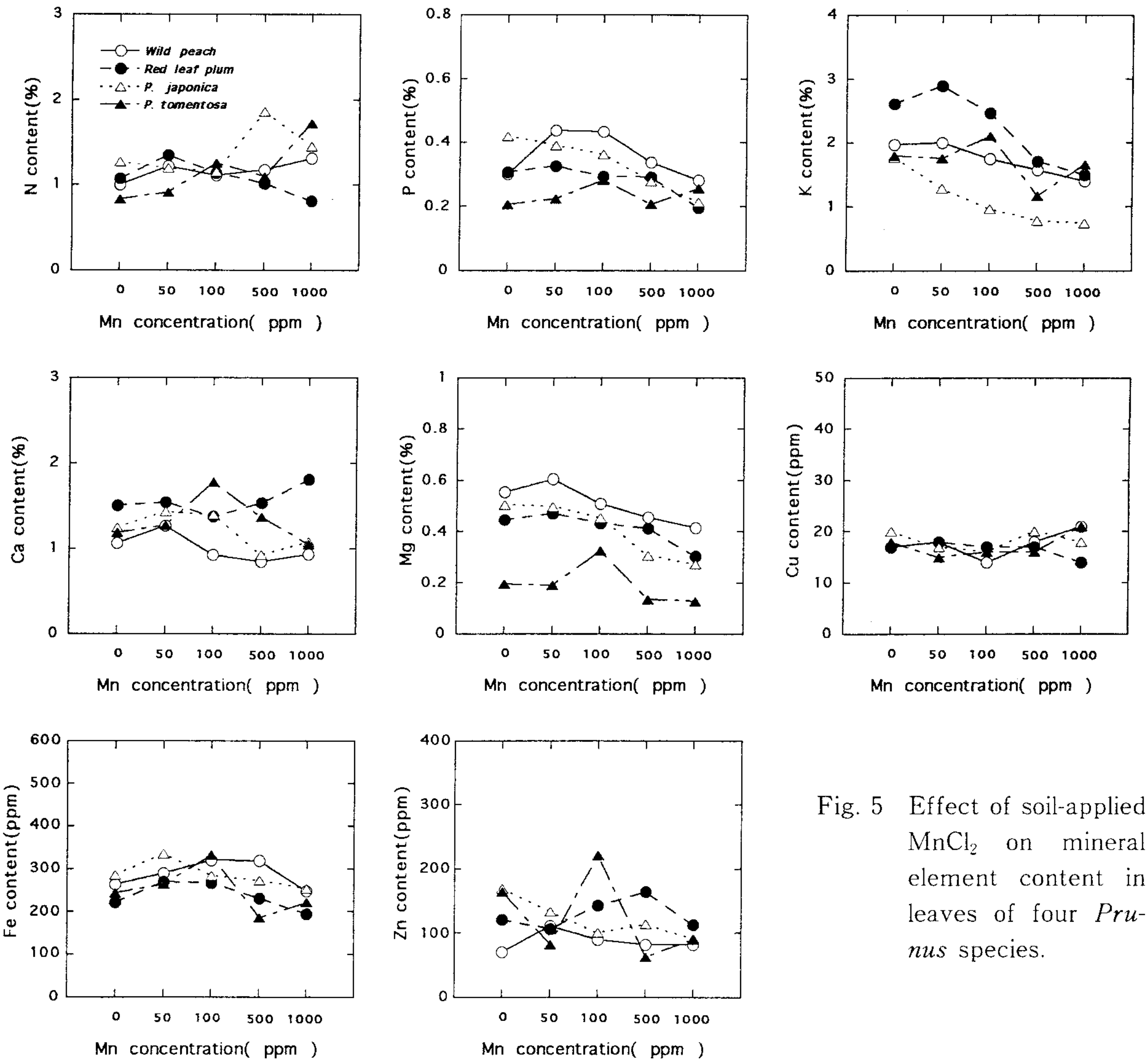

Fig. 5 Effect of soil-applied $MnCl_2$ on mineral element content in leaves of four *Prunus* species.

By employing 'Ohkubo' peach trees grafted on wild peach, *P. tomentosa* and *P. japonica*, to which 1, 5, 25 ppm Mn solution was drenched, Ogata et al.[6] found that Mn accumulated in the following order; *P. tomentosa* > *P. japonica* > wild peach in the leaves and stems, although the order was shifted to wild peach > *P. tomentosa* > *P. japonica* in the fine roots. In our present results too, wild peach showed greater root Mn content than *P. japonica* and *P. tomentosa* in the non-treated control plots. However, at high dosages Mn content in the roots was reversed; wild peach was lower than the dwarfing rootstocks.

These facts indicate that Mn easily moves from roots to leaves when *P. japonica* and *P. tomentosa* are employed as rootstocks. In this regard, Aoba et al.[1,2] reported that *Malus prunifolia* accumulated Mn in the roots but that Mn hardly moved to the above-ground parts while the reverse was true for *M. sieboldii*.

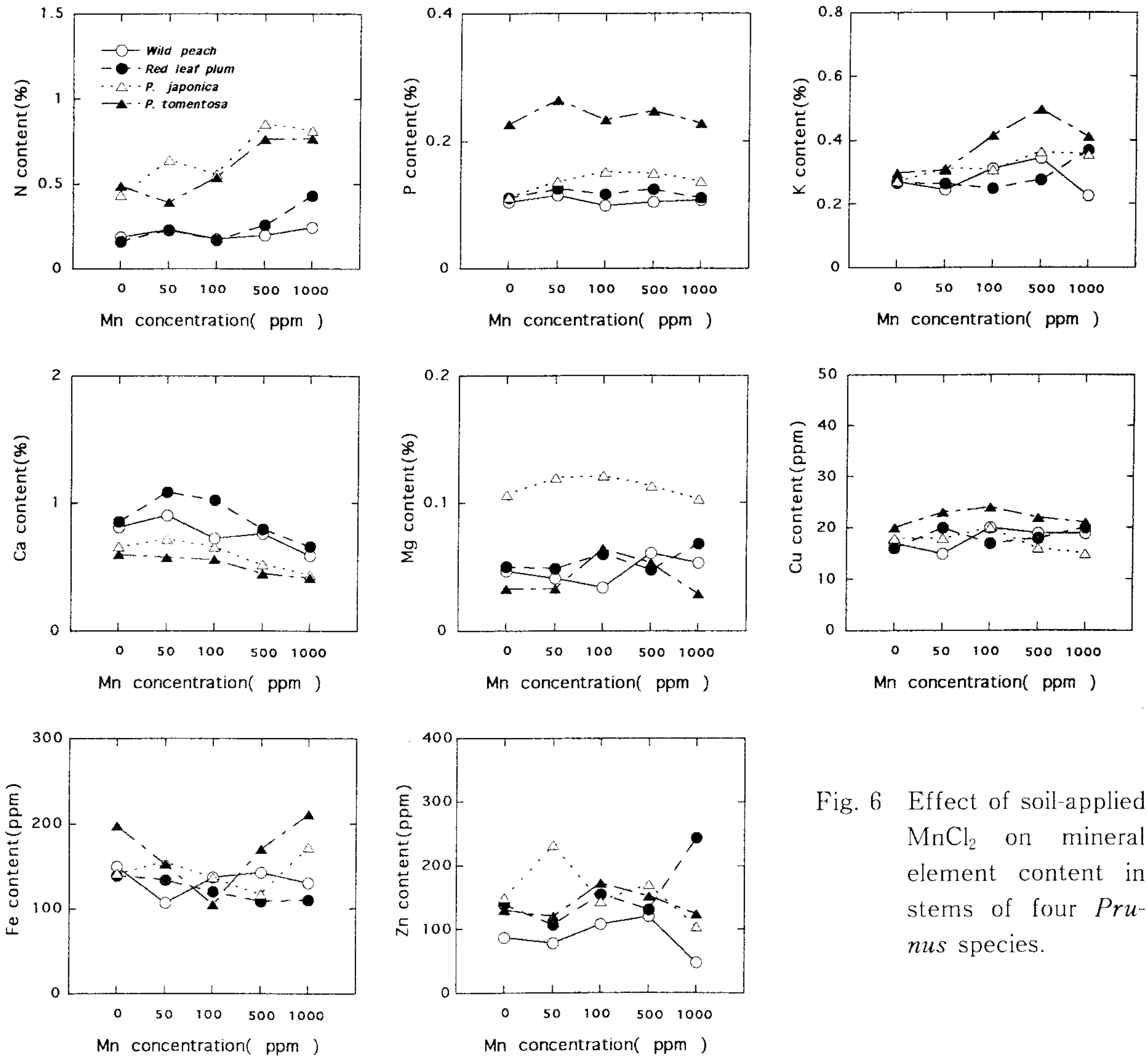

Fig. 6 Effect of soil-applied $MnCl_2$ on mineral element content in stems of four *Prunus* species.

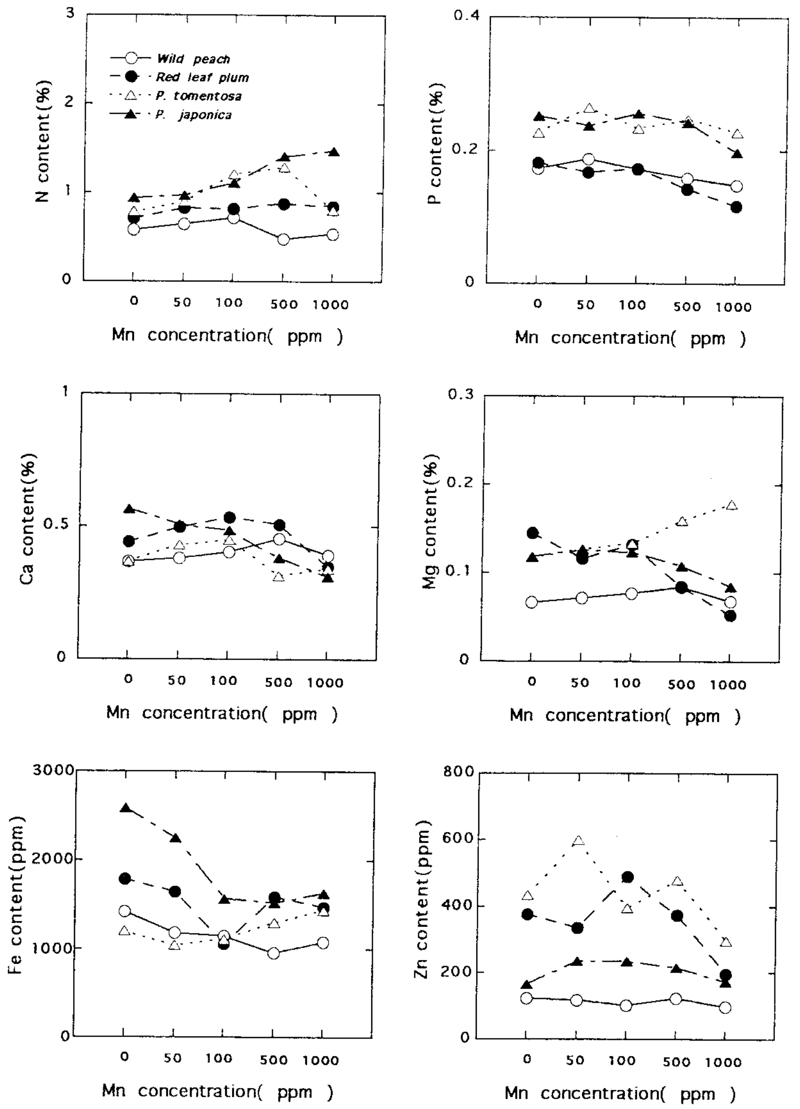

Fig. 7 Effect of soil-applied $MnCl_2$ on mineral element content in roots of four *Prunus* species.

Nutrient status as affected by soil-applied Mn

Figs. 5 to 7 show the nutrient element content of leaves, stems and roots as affected by soil-applied Mn. Leaf K content of all the species tended to decrease with increasing Mn concentrations. Likewise leaf Mg content slightly decreased with the increasing Mn dosages(Fig. 5). On the other hand, Mn treatment increased stem N content in *P. japonica*, *P. tomentosa* and red leaf plum but this was not true for wild peach. Stem Ca content was slightly decreased by the treatment. Stem P content in *P. tomentosa* and Mg in *P. japonica* were consistently higher than those in the other *Prunus* species irrespective of Mn treatment(Fig. 6). Root K content was slightly reduced at 500 and 1000 ppm $MnCl_2$ except for wild peach. Root Fe content in *P. japonica* was greatly declined by Mn treatment(Fig. 7).

In conclusion, *P. japonica* and *P. tomentosa* easily transport Mn from the roots to the above-ground parts in both their own-rooted and grafted trees. In the course of this experiment, red leaf plum rootstocks exhibited vigorous growth until the fourth year, but they suddenly declined tree vigor in the fifth season probably due to graft-incompatibility.

Literature Cited

(1) Aoba K., K. Sekiya and Y. Katakura. 1980. Absorption and translocation of manganese in *Malus prunifolia* and *M. sieboldii* trees. Jpn. J. Soil Sci. Plant Nutr. 51 : 405–410. (In Japanese)

(2) Aoba K., K. Sekiya and Y. Katakura. 1980. Forms of manganese as affected by scion and rootstock of apple trees. Jpn. J. Soil Sci. Plant Nutr. 51 : 411–417. (In Japanese)

(3) Kubota N., K. Shimamura, H. Mimura and M. Nakano. 1986. Changes in the content of total phenolic compound during fruit ripening of peaches as affected by different rootstocks. HortSci. 21 : 765.

(4) Mizutani F., M. Yamada, T. Taniguchi, K. Koizumi, A. Sugiura, T. Tomana and K. Kadoya. 1985. Dwarfing effect of *P. japonica* and *P. tomentosa* rootstocks on 'Ohkubo' peach trees. J. Japan. Soc. Hort. Sci. 54 : 327–335. (In Japanese with English summary)

(5) Murase S., K. Suzuki and T. Yamazaki. 1986. Studies on dwarfing rootstocks of peach. 1. Survival, growth, yield and fruit quality of young peach trees as affected by rootstocks, *Prunus japonica* Thunb., *Prunus tomentosa* Thunb. and *Prunus persica* Batsch. Bull. Fruit Tree Res. Stn. A 13 : 31–49. (In Japanese with English summary)

(6) Ogata T., I. Kataoka, A. Sugiura and T. Tomana. 1986. Mineral absorption of peach trees as affected by dwarfing rootstocks. Abstr. Japan. Soc. Hort. Sci. Spring Meet. 64–65. (In Japanese)

(7) Ogata T., I. Kataoka, A. Sugiura and T. Tomana. 1989. Effect of several rootstocks on mineral nutrient absorption of peach, nectarine, and plum. J. Japan. Soc. Hort. Sci. 57 : 608–614. (In Japanese with English summary)

(8) Suzuki K., S. Murase and T. Yamazaki. 1986. Preliminary research for dwarfing rootstock of peach and cherry. Bull. Fruit Tree Res. Stn. A 13 : 21–29. (In Japanese with English summary)

(9) Tsuruta T., Y. Yamada, W. Koyaizu and M. Adachi. 1985. Studies on the dwarfing rootstocks for peach. 1. Graft affinity on the combination of rootstock and scion varieties. Bull. Yamanashi Fruit Tree Exp. Stn. 6 : 51–56. (In Japanese with English summary)

(10) Tsuruta T., Y. Yamada, W. Koyaizu, H. Endo, H. Kubota and M. Adachi. 1985. Studies on the dwarfing rootstocks for peach. 2. Effect of several rootstocks on the growth and development of scion varieties. Bull. Yamanashi Fruit Tree Exp. Stn. 6 : 57–82. (In Japanese with English summary)

矮性台木がモモの無機成分含量に及ぼす影響

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摘要

矮性台木がモモの葉の無機成分含量に及ぼす影響について調査をした。ニワウメとユスラウメはモモの台木として用いると、葉内Ｍｎ含量を著しく高めた。野生モモ、ニワウメ、ユスラウメの実生苗とベニスモモの挿し木苗に $MnCl_2$ の土壌処理を施したところ、500及び1000 ppmでユスラウメの、1000 ppmでニワウメとベニスモモの新梢生長を抑制したが、野生モモでは抑制効果が見られなかった。どの組織でもＭｎ含量は2000 ppmで飽和状態になるように思われた。ニワウメとユスラウメでは100 ppm$MnCl_2$ 処理で葉内Ｍｎ含量が飽和に達するのに対し、ベニスモモでは500 ppmで飽和に達した。しかしながら、野生モモでは1000 ppm処理でも飽和に達しなかった。ニワウメは茎で、ベニスモモは根で最もＭｎを集積する傾向が見られた。いずれの種でも処理Ｍｎ濃度が高くなるにつれて、葉内Ｋ及びＭｇ含量が減少する傾向が見られた。